

Flowers and Insects. III.

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*Nelumbo*¹ *lutea* Planch.—The flowers are female in the first stage. On the first day the petals separate at tips, so that insects can enter and crawl about upon the carpophore and over the stigmas. At this time the anthers are indehiscent and are pressed close against the sides of the carpophore, being held in this position by the erect petals. The claw-like tips of the anthers, the only parts of the stamens now visible, form a close circle between the petals and the edge of the carpophore, thus opposing insects which might attempt to reach the pollen.

On the second day, when the petals begin to separate, insects can only reach the anthers, which are now discharging pollen, by crawling over the stigmas. Later, when the petals become widely expanded and the anthers fall upon them, insects no longer light upon the carpophore.

Delpino regards flowers of this genus as specially adapted to beetles which he supposes visit the flowers to gnaw the carpophore. I have never seen them eating this part, nor are they sufficiently abundant on the flowers to be of much use. Moreover, they remain almost stationary and seldom fly from flower to flower. Delpino has classed the flowers of Nymphæaceæ in general as *cantharophilous*, it seems to me without enough evidence. I have found *Nymphæa*¹ and *Nelumbo* visited only for pollen and *Nuphar*² both for pollen and nectar. The principal visitors are Andrenidæ, especially species of *Halictus*, and *Syrphidæ*.

Visitors (observed on 3 days between July 26 and August 12): Hymenoptera—*Apidæ*: (1) *Apis mellifica* L. ♂, c. p., ab.; (2) *Ceratina dupla* Say ♀. *Andrenidæ*: (3) *Agapostemon radiatus* Say ♀, ab.; (4) *Augochlora pura* Say ♀, ab.; (5, 6) *Halictus* spp. ♀, ab.; (7) *H. ligatus* Say ♀; (8) *H. Lerouxii* St. Farg. ♀ (= *parallelus* Sm.); (9) *H. parallelus* Say ♀, ab. (= *occidentalis* Cr.); (10) *H. pilosus* Sm. ♀, ab.; (11) *H. confusus* Sm. ♀, ab., all c. p.; (12) *Prosopis*

¹On the fertilization of *Nelumbo* see Delpino: *Ulteriori osservazioni sulla dicogamia nel regno vegetale*; and Comes: *Studi sulla impollinazione in alcune piante*.

²BOT. GAZETTE, XIV, 122-125.

sp. ♀; (13) *P. affinis* Sm. ♀, both f. p. *Scoliidæ*: (14) *Myzine interrupta* Say; (15) *Scolia bicincta* F.

Diptera—*Syrphidæ*: (16) *Pipiza pullchella* Will. ab.; (17) *Chrysogaster nitida* Wied.; (18) *Syrphus ribesii* L.; (19) *Mesografta marginata* Say; (20) *Sphærophoria cylindrica* Say; (21) *Syritta pipiens* L., all f. p. *Ephydridæ*: (22) *Notiphila unicolor* Lw., f. p.

Coleoptera—*Coccinellidæ*: (23) *Megilla maculata* De G.; (24) *Hippodamea 13-punctata* L. *Cerambycidæ*. (25) *Lep-tura plebeja* Rand. *Chrysomelidæ*: (26) *Diabrotica 12-punctata* F., ab., all f. p.

Workers of *Bombus separatus*, *B. americanorum*³ and *B. scutellaris* dropped into the flowers, but immediately flew away, as if they had failed to find what they sought. I also found *Bombus virginicus*, *Agapostemon radiatus* and *Lucilia cornicina* dead in the flowers, where they had probably been enclosed by the petals and suffocated by the heavy odor.⁴

Dentaria laciniata Muhl.—This flower agrees in most respects with *Cardamine pratensis*, as described by Müller. But the nectaries which occupy the position of the two missing stamens are of nearly or quite the same importance as those surrounding the bases of the two short stamens. Accordingly the saccate bases of the sepals which hold the nectar from these glands are of about the same size as the others. The stigma commonly surpasses the anthers, so that it strikes the bee in advance of them, but there is a chance of self-pollination in absence of insects.

The erect sepals and the claws of the petals measure about 8 mm., and with the stamens and style narrow all ways of access to the nectar, so that only insects with a tongue 8 mm., or longer, can reach the nectar with perfect ease. But short-tongued bees sometimes manage to force their way in so as to reach the sweets. The flowers are white, or sometimes with a purplish tinge, and grow in rather conspicuous umbels. There are more long-tongued bees than in Müller's list of visitors of *C. pratensis*.

Visitors (observed on 7 days, between April 2 and 20):

³ *Bombus americanorum* Fabr. is our common bumble bee. For a long time it has been mixed up with *B. pennsylvanicus* De Geer, but it is a distinct species, and *B. elatus* Fabr. (*Apathus? elatus*) is its male. I have taken the sexes of *B. pennsylvanicus* in copula. I have also taken *B. elatus* in copula with *B. americanorum*. Three nests of the latter which I opened contained no male bees except *B. elatus*. The nest mentioned in Proc. Ent. Soc. Phil., II, 164, said to contain 6 females and 31 workers of *B. pennsylvanicus* and 21 males of *Apathus elatus*, must have belonged to *B. americanorum*.

⁴ Delpino mentions that insects are so killed in flowers of *N. speciosa*.

Hymenoptera—*Apidae*: (1) *Apis mellifica* L., s. and c. p.; (2) *Bombus separatus* Cr. ♀, s.; (3) *B. virginicus* Oliv. ♀, s.; (4) *B. americanorum* F. ♀, s.; (5) *Synhalonia honesta* Cr. ♂ ♀, s.; (6) *Ceratina dupla* Say ♂ s.; (7) *Osmia lignaria* Say ♂, s.; (8) *Nomada* sp. ♀, s. *Andrenidæ*: (9-11) *Andrena* spp. ♂ ♀, s.; (12) *Halictus* sp. ♀, s.; (13) *H. confusus* Sm. ♀, s.; (14) *H. stultus* Cr. ♀, c. p.

Diptera—*Bombylidæ*: (15) *Bombylius fratellus* Wied. s. *Syrphidæ*: (16) *Syrphus ribesii* F.; (17) *Sphærophoria cylindrica* Say, both f. p.

Lepidoptera—*Rhopalocera*: (18) *Lycæna comyntas* Godt.; (19) *Papilio ajax* L.

At Madison, Wis., in May, Prof. Trelease found it visited by *Ceratina dupla*, *Osmia albiventris*, ♂, and *Pieris rapæ*.

Geranium maculatum L.⁵—The flower agrees with the larger flowered species (*G. palustre* and *pratense*) described by Müller. The five outer stamens discharge their pollen over the center of the flower, and afterwards the five inner do the same. The anthers commonly fall off before the stigma is receptive, and the power of self-fertilization is lost. I have observed that the flowers change slowly in bad weather; some of them are in the male stage for three days and others in the female stage for as long. But on warm fair days they go through both stages on the same day.

Some small insects light upon the petals and are able to reach the nectar, though they are of doubtful value, since they are by no means certain to touch the anthers and stigmas. Müller found species of *Halictus* especially numerous on *G. palustre*, and I have found several species of *Andrenidæ* on this plant; but the larger bees seem to be more useful.

Visitors (observed on seven days between May 1 and 21): Hymenoptera—*Apidae*: (1) *Apis mellifica* L. ♀; (2) *Bombus vagans* Sm. ♀; (3) *B. americanorum* F. ♀; (4) *Synhalonia speciosa* Cr. ♀; (5) *Ceratina dupla* Say ♀; (6) *Osmia montana* Cr. ♂. *Andrenidæ*: (7-9) *Andrena* spp. ♂ ♀, s. and c. p.; (10) *Augocholora pura* Say ♀; (11) *Halictus coriaceus* Sm. ♀; (12) *H. pilosus* Sm. ♀; (13) *H. confusus* Sm. ♀.

Diptera—*Empidæ*: (14) *Empis labiata* Lw. *Syrphid*: (15) *Helophilus latifrons* Lw., f. p.

⁵ See Macloskie: BOT. GAZ., IX, 157. For references to literature of pollination of Geraniaceæ see Trelease; North Am. Geraniaceæ, Mem. Bost. Soc. Nat. Hist., IV, 101. For illustration of this species see Goodale: Wild Fls., Pl. III.

Lepidoptera—*Rhopalocera*: (16) *Colias philodice* Godt. *Sphingidæ*: (17) *Hemaris thysbe* F.—all only sucking except 7-9 and 15.

At Madison, Wis., between May 13 and June 1, Prof. Trelease found as visitors: *Nomada bisignata* Say, *N. articulata* Sm., *Augochlora pura* Say, and *Andrena* sp., all sucking.

*Impatiens*⁶ *fulva* Nutt.—The flowers of this species, and of the next, are male in the first stage as is well known. The anthers silt out a great quantity of pollen when struck by a bee, and the stigma is receptive after the anthers fall. Compared with *I. pallida* this plant shows three peculiarities which I think favor humming-birds, viz., the red color, the small landing-place, and the longer and narrower posterior sepal. The landing is about 6 mm. long and 15 mm. wide, while in *I. pallida* it is 12 mm. long and 25 mm. wide and forms a more convenient resting place for bees. However, the form of *I. fulva* so closely resembles that of *I. noli-tangere*, which was developed beyond the range of humming-birds, that it can hardly be explained as a result of bird selection. It originally must have had differences which led the birds to prefer it to *I. pallida*. There is one peculiarity, however, which may have been produced through the influence of birds, and that is the accumulation of red spots on the original ground color. I have elsewhere expressed the view that irregular bird-flowers were originally modified by bees⁷ and have been usurped by birds. From its color, and from the fact that humming-birds are the principal visitors, I regard it as a bird-flower, although bees and butterflies also occur as guests.

The posterior sepal is about 22 mm. long, and its spur, which is commonly coiled upon itself, is about 10 mm.

Visitors: Birds—*Trochilidæ*: (1) *Trochilus colubris* L., ab.

Hymenoptera—*Apidæ*: (2) *Apis mellifica* L. ♀, s. and c. p. Snyder's⁸ statement that it can not effect crossing is not true in my neighborhood; (3) *Bombus virginicus* Oliv. ♀, s. and c. p.; (4) *B. americanorum* F. ♂ ♀, s.; (5) *Melissodes bimaculata* Say ♀, s.; (6) *Megachile brevis* Say ♀, c. p., hangs under the anthers so as to bring her abdominal scopa in con-

⁶ On the literature of the genus see Trelease: l. c., 102.

⁷ Bot. Gaz. XIII. 228.

⁸ Am. Nat. xiv. 126.

tact with them and only visits flowers in the male stage. *Andrenidæ*: (7) *Augochlora pura* Say ♀, c. p., works out the pollen with her jaws and front feet, not touching stigma; (8) *Halictus confusus* Sm. ♀, c. p., like no. 6.

Lepidoptera—*Rhopalocera*: (9) *Papilio troilus* L. s.

Coleoptera—*Chrysomelidæ*: (10) *Diabrotica 12-punctata* F., gnaws holes in spurred sepal.⁹

Nos. 1-5 and 8 are useful visitors, while the rest are not. Differences in the pollen-collecting habits of *Bombus* and *Megachile* are well illustrated in this case. The former receives pollen on the dorsal surface of her thorax and wipes it off with her front legs to place it in her baskets, the latter turns so as to receive it directly in her scopa. Small species of *Halictus* commonly visit flowers adapted to larger insects to collect pollen directly from the anthers or to glean stray grains which are scattered about the flower. In the latter case they do no harm. The *Syrphidæ* also often act as gleaners of stray pollen, and only do harm when they eat it directly from the anthers.

Pollen-gathering is illegitimate behavior in this flower, since it leads the bees to pay more attention to the flowers which are in the male stage. When 2 and 3 are after pollen they neglect flowers in the second stage, since they instantly perceive that the anthers have fallen. The humming-bird coming only for nectar, and being the most rapid flier, is by far the most useful visitor, and it is but natural that it should have most influence in modifying the flower.

Impatiens pallida Nutt.—The flower is "pale-yellow, sparingly dotted with brownish red." It is much larger than in *I. fulva*, and has a shorter (13 mm.) and broader posterior sepal and a large horizontal landing—characters which favor humble-bees. The incurved spur measures about 6 mm. Humble-bees are more abundant and more constant in their visits than in *I. fulva*, while humming-birds were not seen visiting the flower.

Visitors: Hymenoptera—*Apidæ*: (1) *Bombus virginicus* Oliv. ♂, s. and c. p., ab.; (2) *B. americanorum* F. ♂, s. ab.; (3) *Megachile brevis* Say ♀, c. p., behaves as with *I. fulva*. *Andrenidæ*: (4) *Halictus* sp., s., not touching anthers and stigmas.

Diptera—*Syrphidæ*: (5) *Rhingia nasica* Say, s. and f. p.,

⁹ Mutilation or perforation of the flowers of this species was recorded by Bailey: *Torrey Bull.* vi. 173; *Trelease*: *ibid.* vii. 20; *Van Ingen*: *BOT. GAZ.* XII. 229.

not touching anthers when sucking. Several species of Syrphidæ eat pollen which is scattered on landing. Only nos. 1 and 2 are useful visitors.

Staphylea trifolia L.—Prof. W. J. Beal¹⁰ examined the flowers of this plant and concluded “that the chances are better for cross-fertilization than otherwise.” But Mr. Meehan¹¹ has interpreted it as adapted to self-fertilization. On the other hand, Dr. Gray¹² held that the flower is proterogynous and cross-fertilized by bees, and my observations led me to the same conclusion, while still unaware of his view. I find from Prof. Trelease’s notes that he too regarded the flower as proterogynous. Newly opened flowers show a broad, three-lobed stigma nearly closing the entrance, and the still indehiscent anthers crowded under it. The surface of the stigma is always in advance of the anthers, and can hardly become thoroughly dusted with their pollen, even if it can receive enough for self-fertilization. The most that can be said is that the flower is self-fertilized in absence of insects—a very different thing from saying that it is adapted to self-fertilization. But the small number of fruit compared with the number of flowers leads me to doubt whether self-fertilization occurs, even when insects fail. Nectar is secreted by the disk surrounding the base of the ovary. The pendulous flower is about 6 mm. deep and the sepals and petals are erect and closely approximated, so that the flower has much the same form as in the gamopetalous genus *Gaylussacia* and has a like effect in excluding insects, although the petals are more yielding. The ovary, filaments and petals within are very hairy, and this also aids in making the honey less accessible to short tongues and in excluding small intruders. The flower thus favors long-tongued bees, although shorter-tongued insects sometimes succeed in forcing their way into the flowers far enough to reach the nectar.

Visitors (observed in five days, between April 23 and May 11): Hymenoptera—*Apidæ*: (1) *Apis mellifica* L. ♀, s. c. p., ab.; (2) *Bombus virginicus* Oliv. ♀; (3) *B. vagans* Sm. ♀; (4) *B. americanorum* F. ♀—all 3 s., ab. *Andrenidæ*: (5–8) *Andrena* spp. ♂ ♀, s. and c. p., ab.; (9) *Halicictus* sp. ♀, s.; (10) *H. coriaceus* Sm. ♀, s.; (11) *Colletes inæqualis* Say ♂, s. *Vespidæ*: (12) *Vespa maculata* L. s.

¹⁰Am. Naturalist i. 258.

¹¹Proc. Acad. Nat. Sci. Phila., 1876, 108.

¹²See Just’s Bot. Jahresbericht iv. 939.

Diptera—*Empidæ*: (13) *Empis* sp., s. *Syrphidæ*: (14) *Eristalis flavipes* Walk., f. p.

Lepidoptera—*Rhopalocera*: (15) *Nisonides juvenalis* F. s.

Coleoptera—*Scarabacidæ*: (16) *Euphoria sepulchralis* F. f. p.

Ceanothus Americanus L.—The flowers and their pedicels are white. The stems are surmounted by many umbel-like clusters of flowers, and many stems are crowded together; so that insects are attracted for a considerable distance by what seems one large bunch of white flowers. Each hood of a petal encloses an anther, and the petal and stamen rise together. The peculiar form of the petals is associated with a peculiar disposition of the sepals, which serve to conceal the nectar, so as to limit the visitors to a more diligent set than would predominate if the nectar were more freely exposed. The nectar is secreted on a broad disk which is concealed by the sepals remaining strongly closed over it. A petal and an anther have thus to be liberated through the narrow slit between two sepals, and the form of the blade of the petal is to allow it to escape and to free the anther with it. In character of visitors the plant resembles those Umbelliferæ in which the disk is covered by the incurved petals.

Visitors (observed on five days between June 19 and 29):
Hymenoptera—*Apidæ*: (1) *Bombus separatus* Cr. ♀, s. and c. p.; (2) *B. pennsylvanicus* DeG. ♀, c. p.; (3) *Ceratina dupla* Say ♂, s.; (4) *Megachile brevis* Say ♀, s. and c. p.; (5) *Heriades carinatum* Cr. ♀, s. and c. p.; (6) *Nomada incerta* Cr. ♀, s.; (7) *Calliopsis andreniformis* Sm. ♂, s. *Andrenidæ*: (8) *Macropis* sp. ♂, s.; (9) *Augochlora pura* Say ♀, s. and c. p.; (10) *Halictus pectoralis* Sm. ♀, s. and c. p.; (11) *H. similis* Sm. ♀, s. and c. p.; (12) *H. flavipes* F. ♀, s. and c. p.; (13) *H. confusus* Sm. ♀, s. and c. p.; (14) *H. stultus* Cr. ♀, s. and c. p.; (15) *Sphécodes confertus* Say ? ♂ ♀ s.; (16) *Prosopis affinis* Sm. ♂ ♀, s.; (17) *P. pygmaea* Cr. ♂ ♀, s. *Vespidæ*: (18) *Polistes pallipes* St. Farg. *Eumenidæ*: (19) *Eumenes fraternus* Say; (20) *Odynerus tigris* Sauss.; (21) *O. fulvipes* Sauss.; (22) *O. dorsalis* F.; (23) *O. foraminatus* Sauss.; (24) *O. conformis* Sauss.; (25) *O. pedestris* Sauss.; (26) *O. pennsylvanicus* Sauss. *Crabronidæ*: (27) *Crabro interruptus* St. Farg.; (28) *Oxybelus 4-notatus* Say; (29) *O. frontalis* Rob.; (30) *O. emarginatus* Say. *Philanthidæ*: (31, 32) *Cerceris* spp.; (33) *C. clypeata* Dahlb.; (34) *C. compacta* Cr.; (35) *C. compar* Cr.; (36) *C. rufinoda* Cr.

Larridæ: (37) *Larra acuta* Patton. *Sphæcidæ*: (38) *Ammophila intercepta* St. Farg.; (39) *Pelopocus cementarius* Dru.; (40) *Isodontia philadelphica* St. Farg. *Pompilidæ*: (41, 42) *Pompilus* spp.; (43) *P. tenebrosus* Cr.; (44) *P. marginatus* Say; (45) *P. navus* Cr. *Chrysididæ*: (46) *Hedychrum violaceum* Brullé. *Chalcididæ*: (47) *Leucospis affinis* Say. *Tenthredinidæ*: (48) *Atomacera* sp.—all s. except no. 2.

Diptera—*Chironomidæ*: (49) *Ceratopogon* sp., f. p. *Mycetophilidæ*: (50) *Sciara* sp. *Culicidæ*: (51) sp. *Stratiomyidæ*: (52) *Pachygaster* sp. *Empidæ*: (53) *Empis* sp. *Syrphidæ*: (54) *Paragus bicolor* F.; (55) *Chrysogaster nitida* Wied.; (56) *Syrphus americanus* Wied.; (57) *Allograpta obliqua* Say; (58) *Mesograpta geminata* Say; (59) *M. marginata* Say; (60) *Sphærophoria cylindrica* Say; (61) *Tropidia mammillata* Lw.; (62) *T. quadrata* Say; (63) *Syrilla pipiens* L. *Conopidæ*: (64) *Conops brachyrrhynchus* Macq.; (65) *Zodion fulvifrons* Say; (66) *Oncomyia loraria* Lw. *Tachinidæ*: (67, 68) spp.; (69) *Hyalomyia* sp.; (70) *Cistogaster divisa* Lw.; (71, 72) *Ocyptera* spp.; (73) *Jurinia smaragdina* Macq.; (74) *J. apicifera* Walk.; (75) *Cyphocera ruficanda* v. d. Wulp.; (76) *Micropalpus* sp.; (77) *Exorista* sp.; (78) *Eggeria?* sp.; (79) *Acroglossa hesperidarum* Will? *Sarcophagidæ*: (80, 81) *Sarcophaga* spp. *Muscidæ*: (82) sp.; (83) *Musca domestica* L.; (84) *Lucilia*, sp.; (85) *L. cæsar* L.; (86) *L. cornicina* F. *Anthomyidæ*: (87) *Anthomyia* sp.; (88) *Limnophora* sp. *Trypetidæ*: (89) *Trypeta humilis* Lw? *Sepsidæ*: (90) *Sepsis* sp. *Oscinidæ*: (91, 92) spp.; (93) *Oscinis* sp.—all s. or f. p.

Coleoptera—*Dermestidæ*: (94) *Cryptorhopalum hæmorrhoidale* Lec. *Elateridæ*: (95) *Limonius griseus* Beauv. *Lampyridæ*: (96) *Telephorus scitulus* Say. *Scarabæidæ*: (97) *Trichius piger* F. *Cerambycidæ*: (98) *Typocerus sinuatus* Newm. *Chrysomelidæ*: (99) *Pachybrachys atomarius* Melsh.; (100) *Diabrotica 12-punctata* F.; (101) *D. atripennis* Say. *Ædemeridæ*: (102) *Oxacis thoracica* F. *Mordellidæ*: (103) *Mordella marginata* Melsh. *Curculionidæ*: (104) *Centrinus* sp.; (105) *C. scutellum album* Say; (106) *C. picumnus* Hbst.

Hemiptera—*Capsidæ*: (107) *Calocoris rapidus* Say; (108) *Lygus pratensis* L. *Lygæidæ*: (109) *Lygæus turcicus* F. *Cydnidæ*: (110) *Canthophorus cinctus* P. B.—all s.

Lepidoptera—*Rhopalocera*: (111) *Thecla acadica* Edw.; (112) *T. calanus* Hübn.

Carlinville, Ill.